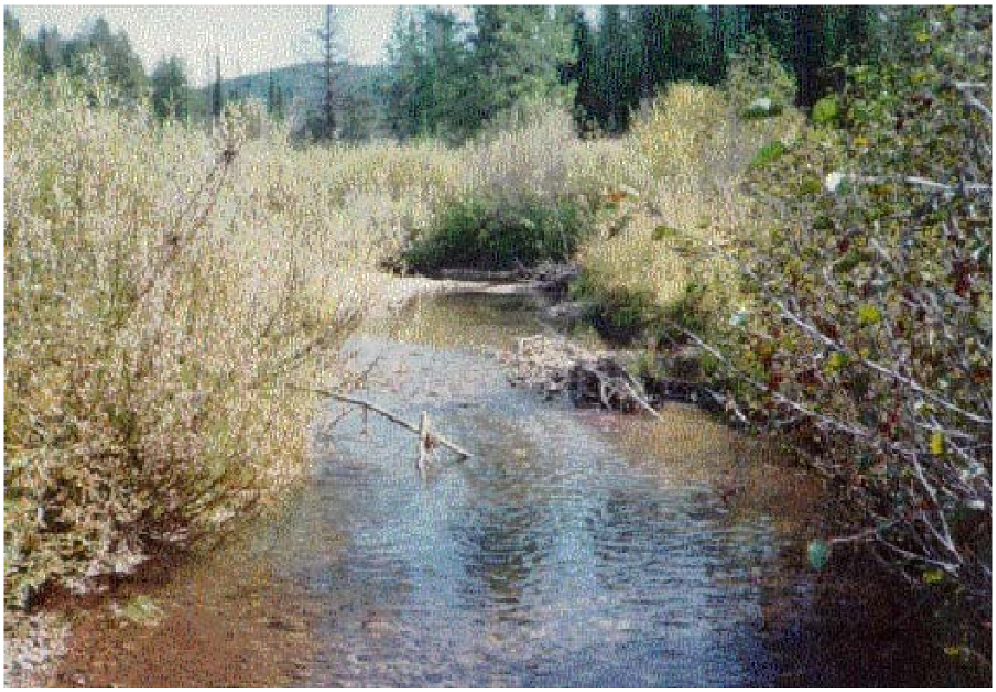
Supplement to the Teton River Total Maximum Daily Load – Moody, Fox, and Spring Creeks



Moody Creek – Photo Courtesy of Derek Blandford, Caribou-Targhee National Forest

FINAL

Department of Environmental Quality

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Moody, Fox and Spring Creeks TMDL
(In the Teton River Subbasin)

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Prepared by:
Mark L. Shumar
State Technical Services Office
Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706

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Abbreviations, Acronyms, and Symbols (Potential)

§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired waterbodies required by this section
µ	micro, one-one thousandth
§	Section (usually a section of federal or state rules or statutes)
ADB	assessment database
AWS	agricultural water supply
BAG	Basin Advisory Group
BLM	United States Bureau of Land Management
BMP	best management practice
BOD	biochemical oxygen demand
BOR	United States Bureau of Reclamation
Btu	British thermal unit
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
cfs	cubic feet per second
cm	centimeters
CWA	Clean Water Act
CWAL	cold water aquatic life
CWE	cumulative watershed effects
DEQ	Department of Environmental Quality
DO	dissolved oxygen
DOI	U.S. Department of the Interior
DWS	domestic water supply
EMAP	Environmental Monitoring and Assessment Program
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
F	Fahrenheit
FPA	Idaho Forest Practices Act
FWS	U.S. Fish and Wildlife Service
GIS	Geographical Information Systems
HUC	Hydrologic Unit Code
IASCD	Idaho Association of Soil Conservation Districts
I.C.	Idaho Code

IDAPA Refers to citations of Idaho administrative rules

IDFG Idaho Department of Fish and Game

IDL Idaho Department of Lands

IDWR Idaho Department of Water Resources

INFISH The federal Inland Native Fish Strategy

IRIS Integrated Risk Information System

km kilometer

km^2 square kilometer

LA load allocation

LC load capacity

m meter

m^3 cubic meter

mi mile

mi^2 square miles

MBI macroinvertebrate index

MGD million gallons per day

mg/L milligrams per liter

mm millimeter

MOS margin of safety

MRCL multiresolution land cover

MWMT maximum weekly maximum temperature

n.a. not applicable

NA not assessed

NB natural background

nd no data (data not available)

NFS not fully supporting

NPDES National Pollutant Discharge Elimination System

NRCS Natural Resources Conservation Service

NTU nephlometric turbidity unit

ORV off-road vehicle

ORW Outstanding Resource Water

PACFISH The federal Pacific Anadromous Fish Strategy

PCR primary contact recreation

PFC proper functioning condition

ppm part(s) per million

QA quality assurance

QC quality control

RBP rapid bioassessment protocol

RDI DEQ's river diatom index

RFI DEQ's river fish index

RHCA riparian habitat conservation area

RMI DEQ's river macroinvertebrate index

RPI DEQ's river physiochemical index

SBA subbasin assessment

SCR secondary contact recreation

SFI DEQ's stream fish index

SHI DEQ's stream habitat index

SMI DEQ's stream macroinvertebrate index

SRP soluble reactive phosphorus

SS salmonid spawning

SSOC stream segment of concern

STATSGO State Soil Geographic Database

TDG total dissolved gas

TDS total dissolved solids

T&E threatened and/or endangered species

TIN total inorganic nitrogen

TKN total Kjeldahl nitrogen

TMDL total maximum daily load

TP total phosphorus

TS total solids

TSS total suspended solids

t/y tons per year

U.S. United States

U.S.C. United States Code

USDA United States Department of Agriculture

USDI United States Department of the Interior

USFS United States Forest Service

USGS United States Geological Survey

WAG Watershed Advisory Group

WBAG *Waterbody Assessment Guidance*

WBID waterbody identification number

WET whole effluence toxicity

WLA wasteload allocation

WQLS water quality limited segment

WQMP water quality management plan

WQRP water quality restoration plan

WQS water quality standard

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize waterbodies that are water quality limited (i.e., waterbodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses three waterbodies in the Teton River Subbasin that have been placed on what is known as the "§303(d) list" as follows:

- Moody Creek (ID17040204SK005_04) – nutrients.
- Fox Creek (ID17040204SK041_02 & ID17040204SK042_02) – temperature.
- Spring Creek (ID17040204SK054_03, ID17040204SK056_02 & ID17040204SK056_03) – temperature.

This TMDL analysis has been developed to comply with Idaho's TMDL schedule. The *Teton River Subbasin Assessment and TMDL* (IDEQ, 2002) document describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Teton River Subbasin located in eastern Idaho. The subbasin assessment is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current §303(d) list of water quality limited waterbodies, of which Moody, Fox and Spring Creeks were a part. The subbasin assessment document examines the current status of §303(d) listed waters, and defines the extent of impairment and causes of water quality limitation throughout the subbasin. Data and information presented in the Teton River subbasin assessment (IDEQ, 2002), plus additional data collected since that time and described in Appendix C of this document were relied upon for completing the Moody, Fox, and Spring Creeks TMDLs. The loading analysis in this document quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Key Findings

- Although undesignated waters, Moody, Fox, and Spring Creeks are presumed to support cold water aquatic life and, at least, secondary contact recreation. Because of the presence of salmonids, Fox and Spring Creeks are also presumed to support salmonid spawning as an existing use.
- In Moody Creek, nutrients are suspected to be a problem and concentrations were over target levels for at least part of the year. Temperature data reveal that both Fox and Spring Creeks exceed temperature criteria for salmonid spawning.
- Numeric targets for nutrients include 0.1 mg/L Total Phosphorus and 0.3 mg/L nitrate + nitrite nitrogen. Salmonid spawning criteria are 13^{o}C daily maximum

and 9°C daily average during the spring spawning period to July 15th. Rainbow and cutthroat trout are the suspected spawners in Fox and Spring Creeks.

- Loading capacity and load allocations for Moody Creek are flow based. The highest measured loads at 73 cfs are reported in Table A. Total phosphorus (TP) and nitrogen (N) need to be reduced by 59% and 66%, respectively. Table B shows loading capacity (criteria) and load allocations for temperature in Fox and Spring Creeks. Fox Creek needs to reduce maximum daily spring spawning temperatures by 37%, and Spring Creek by 44%. Cold water aquatic life criteria are also exceeded in Spring Creek during the summer, requiring a reduction up to 18%.

Table A. Nutrient Load Allocations for Moody Creek.

Parameter	Highest Current Load (lbs/day)	Flow (cfs)	Loading Capacity (lbs/day)	Load Allocation (lbs/day)
TP	87	73	39.4	-51.5 (59% reduction)
N	316	73	118	-209.8 (66% reduction)

Table B. Load Allocations for Temperature in Fox and Spring Creeks.

Fox Creek	Temperature Statistic	Highest Recorded Temperature (Current Load)	Criteria (Loading Capacity)	Load Allocation	% Reduction
Spring Spawning	Maximum Daily	19.8°C	13°C	-6.8°	37%
	Daily Average	14.2°C	9°C	-5.2°	40%
Fall Spawning	Maximum Daily	15.7°C	13°C	-2.7°	20%
	Daily Average	12.3°C	9°C	-3.3°	30%
Spring Creek					
Spring Spawning	Maximum Daily	22.1°C	13°C	-9.1°	44%
	Daily Average	17.5°C	9°C	-8.5°	52%
Summer	Maximum Daily	26.0°C	22°C	-4.0°	18%
	Daily Average	19.2°C	19°C	-0.2°	4%
Fall Spawning	Maximum Daily	20.5°C	13°C	-7.5°	40%
	Daily Average	13.5°C	9°C	-4.5°	36%

1. Introduction

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize waterbodies that are water quality limited (i.e., waterbodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses several waterbodies in the Teton River Subbasin that have been placed on what is known as the "§303(d) list."

The overall purpose of this TMDL is to characterize and document pollutant loads within Moody, Fox, and Spring Creeks of the Teton River Subbasin. Descriptions of these watersheds are found within the *Teton River Subbasin Assessment and TMDL* (IDEQ, 2002) document produced earlier.

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt, with EPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish TMDLs for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the waterbodies to meet their designated uses. These requirements result in a list of impaired waters, called the "§303(d) list." This list describes waterbodies not meeting water quality standards. Waters identified on this list require further analysis. A subbasin assessment and TMDL provide a summary of the water quality status and allowable TMDL for waterbodies on the §303(d) list. The *Teton River subbasin Assessment and TMDL* (IDEQ, 2002) provides this summary for the currently listed waters in the Teton Subbasin.

The subbasin assessment section of that report (Chapters 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Teton Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a waterbody and still allow that waterbody to meet water quality standards (Water quality planning and management, 40 CFR 130). Consequently, a TMDL is waterbody- and pollutant-specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." TMDLs are not required for waterbodies impaired by pollution, but not specific pollutants. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several waterbodies and/or pollutants within a given watershed.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a waterbody by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions. See the Teton River subbasin assessment (IDEQ, 2002) for further information on applicable Idaho water quality standards and targets used for this TMDL. Applicable water quality standards are also listed in Appendix B of this document.

The state may assign or designate beneficial uses for particular Idaho waterbodies to support. These beneficial uses are identified in the Idaho water quality standards (IDAPA 58.01.02.100) and include:

- 01. Aquatic life support – cold water, seasonal cold water, warm water, salmonid spawning, modified

- 02. Contact recreation – primary (swimming), secondary (boating)

- 03. Water supply – domestic, agricultural, industrial

- 04. Wildlife habitats, and 05. aesthetics

The Idaho legislature designates uses for waterbodies. Industrial water supply, wildlife habitat, and aesthetics are designated beneficial uses for all waterbodies in the state. If a waterbody is unclassified, then cold water and primary contact recreation are used as additional default designated uses when waterbodies are assessed.

A subbasin assessment entails analyzing and integrating multiple types of waterbody data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the waterbody (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the waterbody, particularly the identity and location of pollutant sources.
- When waterbodies are not attaining water quality standards, determine the causes and extent of the impairment.

Moody Creek, originating in the Big Hole Mountains and the sole tributary to the South Fork Teton River, was listed as water quality-limited by nutrients on the 1998 303d list. The *Teton River Subbasin Assessment and TMDL* (IDEQ, 2002) determined that the boundaries of the listed segment should change to include from the confluence of North and South Moody Creek to a location where the stream course becomes canal (tentatively identified as the confluence with Woodmansee Johnson Canal). The original 303d listing boundaries were from the Forest Service boundary to the Teton River. The FS boundary is a short distance downstream of the confluence of North and South Moody Creeks. The mouth of Moody Creek is currently identified as the confluence with the Woodmansee Johnson Canal. These boundary changes are relatively minor and should not affect the outcome of the TMDL.

Fox and Spring Creeks are tributaries to the upper Teton River near Victor and Tetonia, respectively. These streams were identified in the *Teton River Subbasin Assessment and TMDL* (IDEQ, 2002) as being water quality limited for sediment and temperature. Sediment was addressed in that document and temperature is addressed here. Both streams were considered rainbow and cutthroat trout spawning waters.

Although undesignated waters, Moody, Fox, and Spring Creeks are presumed to support cold water aquatic life and, at least, secondary contact recreation. Because of the presence of salmonids, Fox and Spring Creeks are also presumed to support salmonid spawning as an existing use.

2. Total Maximum Daily Loads

A Total Maximum Daily Load (TMDL) prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, which receive a load allocation (LA). Natural background (NB), when present, is considered part of the load allocation, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the MOS is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the LC is determined. Then the LC is broken down into its components: the necessary MOS is determined and subtracted; then NB, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation is completed we have a TMDL, which must equal the LC.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. Also a required part of the loading analysis is that the LC be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both LC and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary. These "other measures" must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads, and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

2.1 Instream Water Quality Targets

Moody Creek was previously identified as not meeting beneficial uses due to nutrient pollution in the Teton River SBA and TMDL (IDEQ, 2002). Additionally, Fox and Spring Creeks were identified in that document as needing temperature TMDLs. The goal is to restore "full support of designated beneficial uses" (Idaho Code 39.3611, 3615). In Moody Creek, the beneficial uses affected are likely to be all cold water aquatic life. In Fox and Spring Creeks, the likely affected use is salmonid spawning.

Design Conditions

- The impaired reach for Moody Creek is from the confluence of North and South Moody Creek (approximately ¾ mile above the National Forest boundary).
- The listed segments of Fox and Spring Creeks include from the Idaho-Wyoming border to their mouths.

Target Selection

- The measurable target(s) for instream water quality and loading analysis for Moody Creek are a total phosphorus target of 0.1 mg/L and a nitrogen (NO^2 + NO^3) target of 0.3 mg/L. The phosphorus target emanates from the EPA "Gold Book" criterion for streams and the nitrogen target from the literature, as described in the Teton River subbasin assessment document (IDEQ, 2002).
- The targets for Fox and Spring Creeks are derived from the salmonid spawning temperature criteria (13°C daily maximum, 9°C daily average) for both the spring (up to July 15th) and fall (beginning September 1st) spawning periods. Default spring spawning times (March 15 to July 15) were used in the TMDL because of the presence and concern for rainbow and cutthroat trout. The daily maximum temperature was used specifically as the target temperature.

Monitoring Points

- Moody Creek has been monitored for nutrient and other water quality parameters at three locations over the past two years. These locations, selected by the IASCD, reflect the downstream end of a listed segment, as well as critical reaches further upstream.
- Fox and Spring Creeks have been monitored for temperature at several locations in the lower segments below the National Forest. Fox Creek has been monitored since 1996, the first three sampling years by IDFG. Spring Creek has been monitored since 2000.

Moody Creek

Moody Creek has large fluctuations in discharge (see Figure 37 of IDEQ, 2002). Peak flows averaging around 300 cfs occur during the month of May, and then discharge falls off dramatically to about 10 cfs for the remainder of the year. Additionally, the flow regime is highly altered by agricultural diversion with the lower portions of Moody Creek being dewatered after July.

Data used for this nutrient TMDL were collected subsequent to the Teton River subbasin assessment and TMDL (IDEQ, 2002), and are referenced in Appendix C of the present document. These data are summarized on Figures 1 and 2. Figure 1 shows the recent total phosphorus (TP) monitoring at three locations in Moody Creek. Total phosphorus tends to peak in concentration to 0.2 – 0.3 mg/L during the May peak in discharge, consistent with the idea that phosphorus tends to move with sediment, which moves with flow. During the remainder of the year, TP concentration tends to be at or below the target concentration of 0.1 mg/L. Nitrogen as NO_2 + NO_3 does not necessarily show the same trend with discharge (Figure 2). Nitrates and nitrites when detected (zero concentration reflects below the detection limit of 0.05 mg/L) tend to remain around 0.6 to 1.0 mg/L, higher than the target concentration of 0.3 mg/L.

Figure 1. Total phosphorus concentrations monitored at three locations in Moody Creek during 2001 and 2002. (Data provided by IASCD)

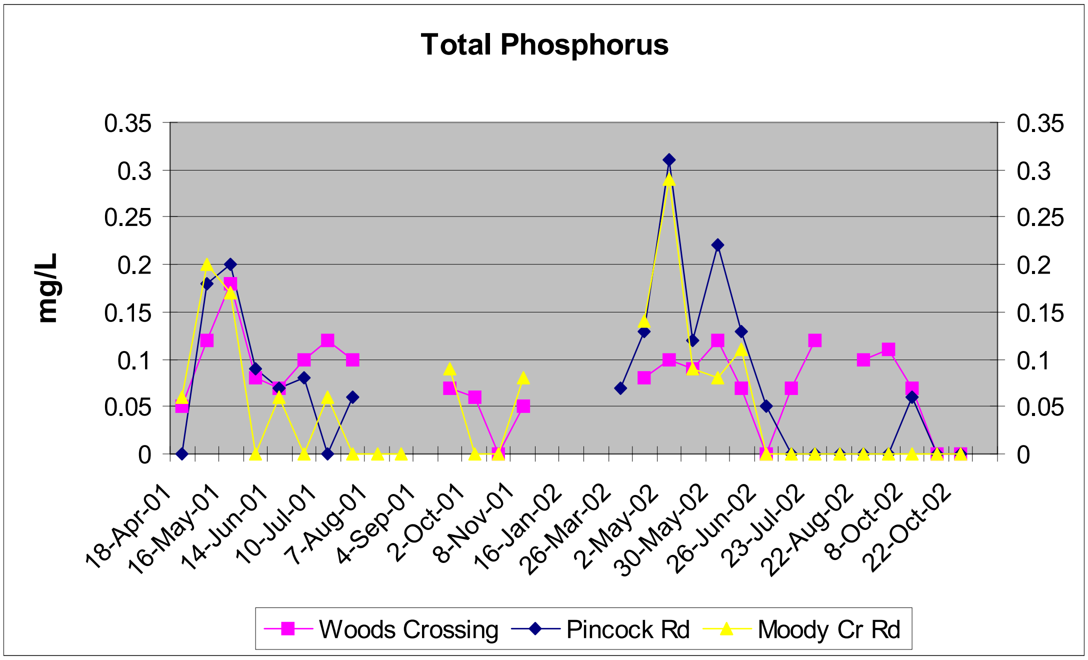


Figure 2. Nitrate plus nitrite concentrations monitored at three locations within Moody Creek during 2001 and 2002. (Data provided by IASCD)

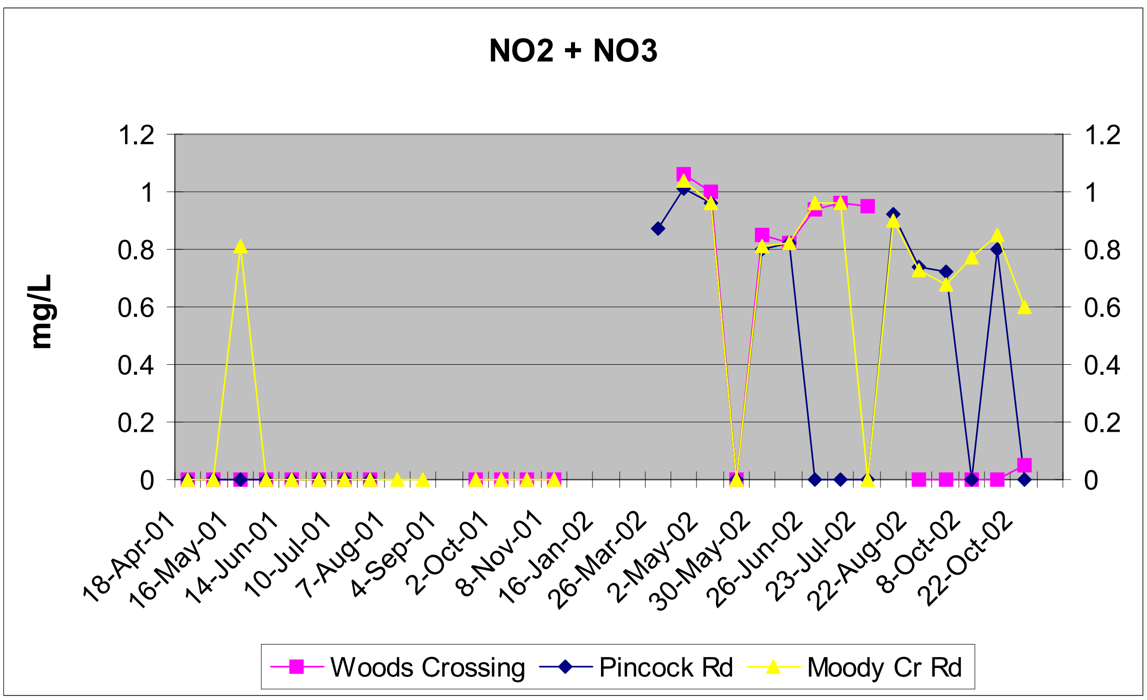


Figure 3. Current Loading of Total Phosphorus.

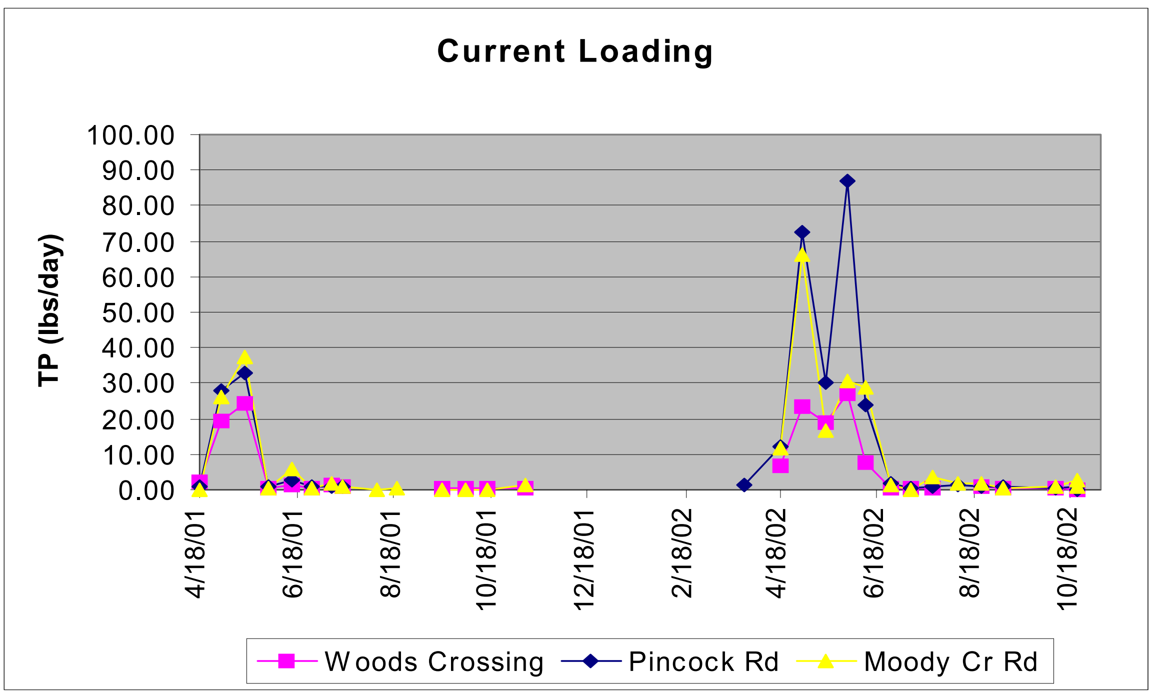
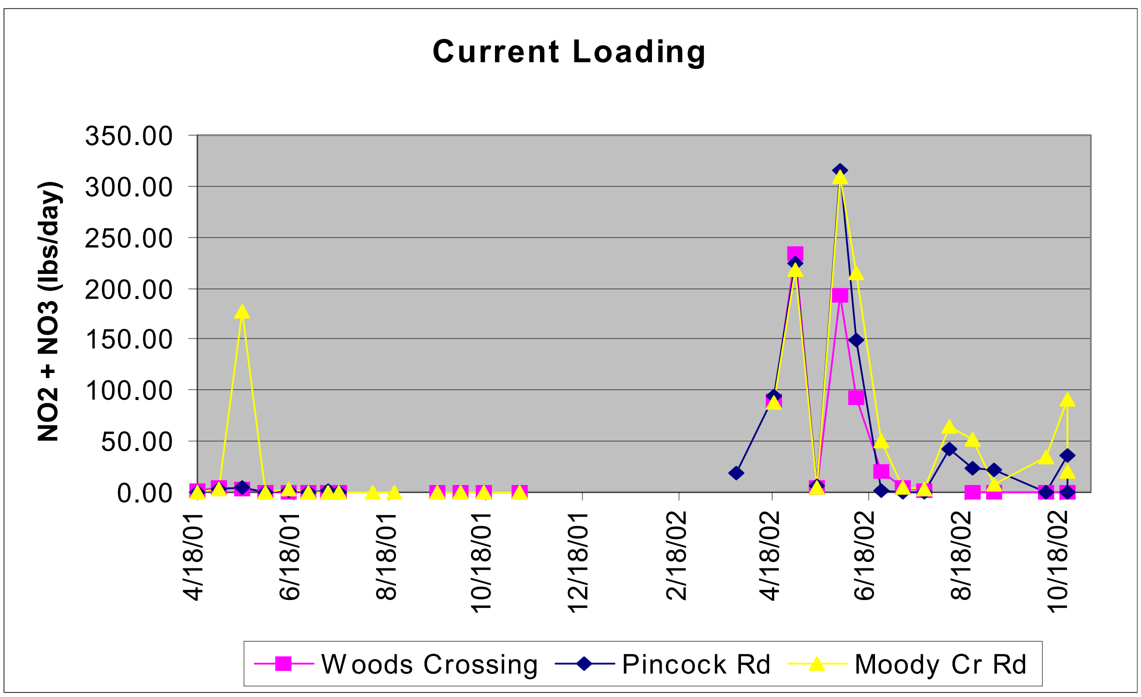


Figure 4. Current Loading of Nitrogen (NO2 + NO3).



Woods Crossing is the upper most sampling site of the three (see Figure 40a of IDEQ, 2002). Moody Creek Road site is near the mouth at Woodsmansee Johnson Canal and Pincock Road is two miles upstream from the mouth. Total phosphorus concentrations in 2002 did not peak at Woods Crossing as they did at the other two sites (Figure 1), and loadings of TP are lower at Woods Crossing (Figure 3). Other than the peak period, the remainder of the data set does not suggest that the lower sites have higher TP concentrations or loading. Nitrogen loading (Figure 4) reflects slightly lower loading rates at the upper site in 2002.

Fox Creek

Fox Creek enters Idaho from the east and becomes several intermittent channels within two miles of the Idaho-Wyoming border. During the irrigation season the bulk of Fox Creek water is diverted into irrigation pipelines and canals. West of Hwy 33 perennial flow is restored by springs for the last two miles of Fox Creek before it enters the Teton River. Fox Creek flows continuously from headwaters to the Teton River for a few weeks in June and July as a result of snowmelt. Upper Fox Creek contains reproducing brook trout. A concrete dam at the National Forest boundary may serve as a migration barrier to these fishes. Spawning rainbow trout have been identified in lower Fox Creek near the Teton River.

Temperatures were recorded in Fox Creek in 1996 through 1998 by IDFG, in 2000 by DEQ and the Forest Service, and again in 2002 by IDEQ. IDEQ recordings in 2000 and 2002 were made in lower Fox Creek west of Hwy 33. The Forest Service monitored temperatures at their boundary near the stateline and recorded no exceedances of criteria in 2000. It is unknown where earlier IDFG recordings were made, although it is presumed to be in lower Fox Creek. No temperature recordings for Fox Creek exceeded criteria for cold water aquatic life (19oC daily average, 22oC daily maximum). All temperature data are available for review from the Idaho Falls Regional Office of the Idaho Department of Environmental Quality.

During the default salmonid spawning periods for spring (beginning of recording to July 15th) and fall (September 1st to end of recording), salmonid spawning criteria (9oC daily average, 13oC daily maximum) were exceeded every year. The highest recorded water temperatures during these spawning periods are listed in Table 1. The highest spring temperatures were between 16o and 20oC. In general, water temperatures would increase rapidly reaching a peak in mid- to late May, decrease temporarily for a time during late May early June, and then rise again during the first part of July. This pattern presumably results from the additions of snowmelt runoff from the higher country in early June. High temperatures during the spring spawning period in some years occurred during the May peak, and were not seen until early July in other years. All spring spawning temperature exceedances occurred in the lower, spring fed portion of Fox Creek within several miles of the Teton River.

Table 1. Highest recorded water temperatures in Fox Creek in five years.

Spring Spawning Period (to 7/15)	1996	1997	1998	2000	2002
Highest Daily Maximum (^oC)	17	17.2	16.7	19.8*	15.9
Highest Daily Average (^oC)	12.2	11.5	11.2	14.2	10.9
Fall Spawning Period (from 9/1)					
Highest Daily Maximum (^oC)	15.5	15.7*	15.7	13.3	13.3
Highest Daily Average (^oC)	11.4	11.1	12.3	9.9	9.9

* Highest recorded temperatures

During the fall spawning period (September 1st to the end of recording), high water temperatures occurred early and were not as high as spring spawning high temperatures. This reflects the rapidly falling temperature regime in early fall consistent with higher elevation areas within the state.

Spring Creek

Spring Creek originates at a small spring-fed pond in Idaho three miles west of the Idaho-Wyoming border. The stream flows south and is joined by North Leigh Creek in about a mile and a half. At approximately one mile east of Tetonia (halfway point for this stream), Spring Creek flows under Hwy 33 and turns west towards the Teton River another three miles or so away.

Fewer temperature data are available for Spring Creek as compared to Fox Creek, and all monitoring was in the lower half of the stream. Water temperatures were measured in one location in Spring Creek in 2000 (at Hwy 33 a mile east of Tetonia), and in two locations in 2002 (1/2 mile south of Tetonia at Cache Road and one mile west of Tetonia at 450W road). The 450W Rd. location west of Tetonia was less than two miles from the mouth of Spring Creek. All temperature data are available for review from the Idaho Falls Regional Office of the Idaho Department of Environmental Quality.

North Leigh Creek is intermittent and diverted for irrigation during the summer. Spring Creek is presumably perennial its entire length, although a one and a half mile stretch west of Tetonia may occasionally go dry. Three age classes of brook trout have been monitored in upper Spring Creek above any temperature monitoring. Like Fox Creek, Spring Creek may experience spawning trout in its lower half towards the Teton River.

Water temperatures in Spring Creek were generally higher than in Fox Creek (Table 2). Fox Creek enjoys spring fed flow in its lower portion providing more water and a cooling effect. Spring Creek does not have springs in the lower segments where temperature was recorded. Spring Creek reached a maximum temperature of 26.0°C during the summer of 2000, exceeding cold water aquatic life criteria for most of July and the first half of August. However, no recordings exceeded cold water aquatic life criteria in 2002. Spring Creek was apparently dry at the lower 450W Rd. site in 2002 suggesting that high temperatures may be in part due to lack of flow.

Spring Creek exceeded spring salmonid spawning criteria by a substantial margin both years. The highest recorded spring water temperature was 22.1°C. Fall salmonid spawning criteria were exceeded as well in 2002, not data were available for 2000.

Table 2. Highest water temperatures in Spring Creek during 2000 and 2002.

Spring Spawning Period (to 7/15)	2000 (Hwy 33)	2002 (450W Rd.)	2002 (Cache Rd.)
Highest Daily Maximum (°C)	22.1*	16.7	19.0

Highest Daily Average (^oC)	17.5	13.1	14.7
Summer (July 15 to Sept 1)			
Highest Daily Maximum (^oC)	26.0*	Dry in August	20.2
Highest Daily Average (^oC)	19.2	Dry in August	16.2
Fall Spawning Period (from 9/1)			
Highest Daily Maximum (^oC)	NA	20.5*	14.8
Highest Daily Average (^oC)	NA	13.5	12.9

* Highest period temperatures

2.2 Load Capacity

Moody Creek

An average annual load may paint an unrealistic picture in a stream with such divergent flow. Therefore, loading capacity, current loads and associated load allocations will be visualized from a flow-based perspective. Loading capacity was calculated for TP (Figure 5) and nitrogen as NO2 + NO3 (Figure 6) using the target concentrations and flows ranging from 10 cfs to 500 cfs. Loading capacity was calculated as pounds per day at each 10 cfs flow interval. Total phosphorus loading capacity at a 0.1 mg/Ltarget varies from 5 lbs/day at 10 cfs to 270 lbs/day at 500 cfs. Likewise, nitrogen loading capacity at the 0.3 mg/L target varies from 16 lbs/day to 809 lbs/day at 10 cfs and 500 cfs, respectively.

Figure 5. Current and Capacity Loading of Total Phosphorus in Moody Creek.

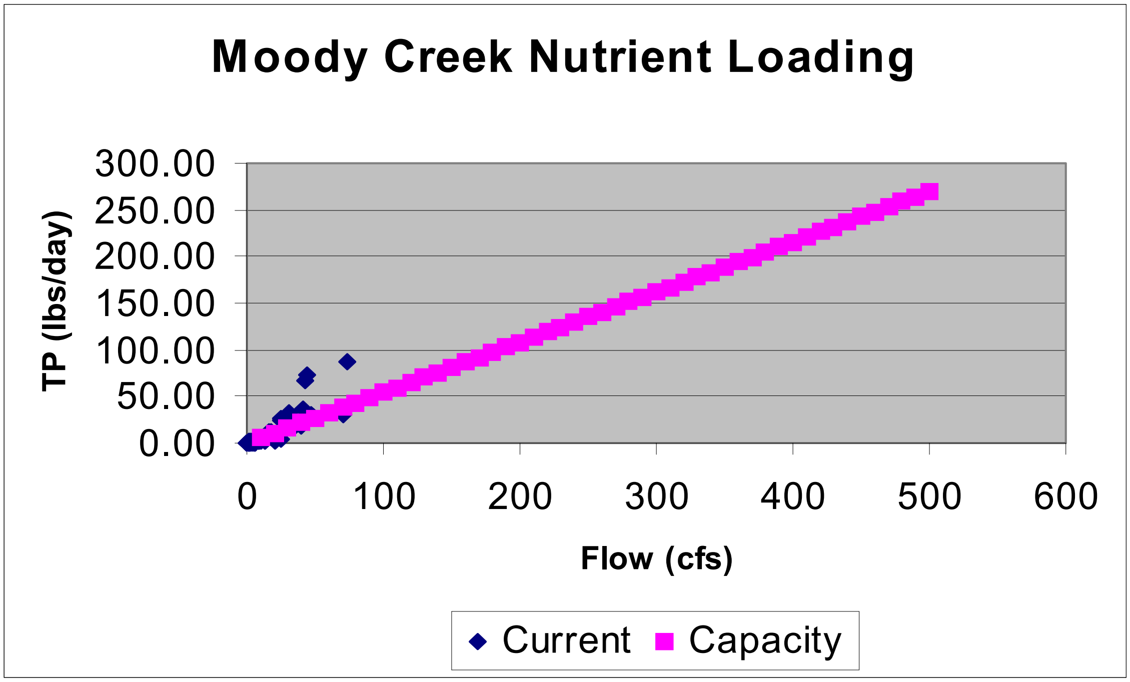
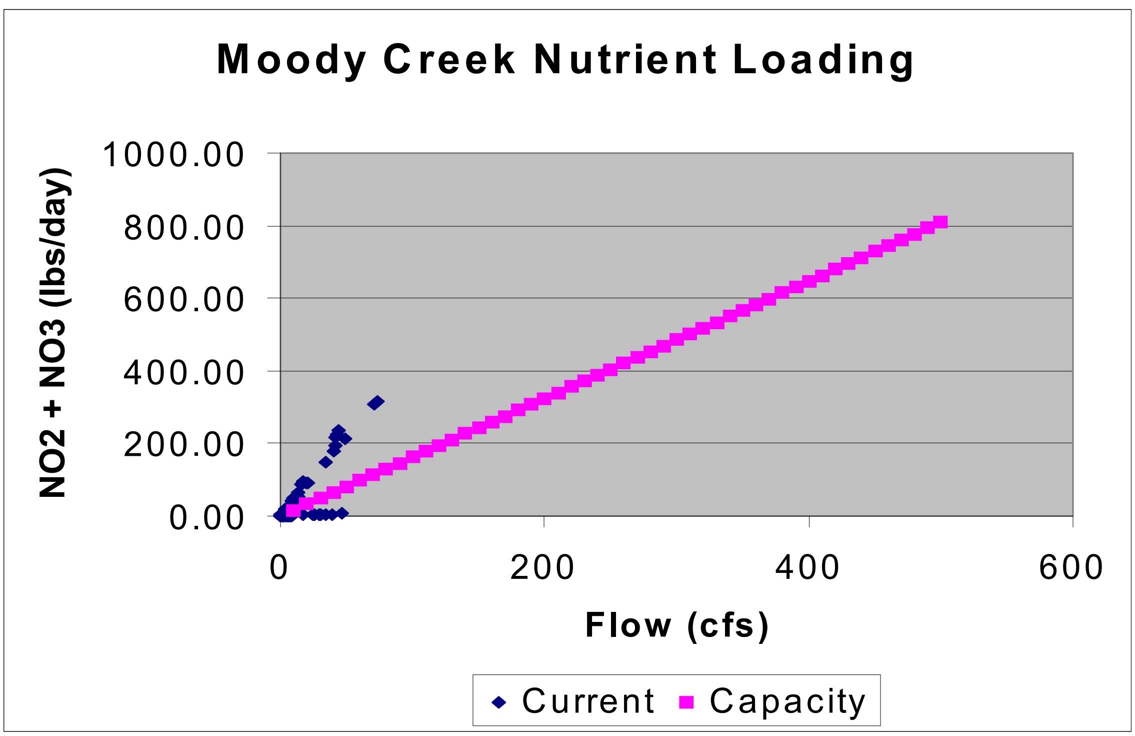


Figure 6. Current and Capacity Loading of Nitrogen in Moody Creek.



- The loading capacity is estimated from the target concentration at a series of flow tier intervals (every 10 cfs).
- The loading capacity assumes no changes in target concentration as a result of season or location.

<u>Fox and Spring Creeks</u>

The loading capacities for Fox and Spring Creeks are based on temperature criteria (see Appendix B). Both streams are considered spring salmonid spawning streams due to the presence of rainbow and cutthroat trout, thus salmonid spawning criteria (13 C daily maximum, 9 C daily average) apply to both streams from the beginning of temperature recording in the spring to July 15th. Additionally, both streams are considered cold water aquatic life streams, and additional criteria (22 C daily maximum, 19 C daily average) apply during the summer months.

- The loading capacity is season specific and should only apply to salmonid spawning areas, however, in flowing streams temperatures above salmonid spawning areas can influence temperatures downstream.
- The use of the highest recorded temperature to compare to the criteria provides an implicit margin of safety over all of the cooler years when temperatures would not be so high.

2.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

<u>Moody Creek</u>

Phosphorus and nitrogen loads currently entering the system are based on all the monitoring data (sites lumped) collected during 2001 and 2002 in Figures 5 and 6. At low flows (below 15 cfs), TP current loading tends to stay at or below loading capacity (Figure 5). At greater flows (15 to 80 cfs), TP loads increase over loading capacity. Because monitoring tends to occur at lower flows rather than at peak discharge, current TP loads are unknown at flows greater than 80 cfs. Nitrogen loading, when detected, tends to be greater than loading capacity throughout the 10 to 80 cfs range (Figure 6).

The current loading trend suggests that as flow increases, so does nutrient loading, and above the loading capacity. However, we must be careful about extrapolating results at higher flows. What may likely occur is a peak in nutrient loading at some intermediate flow with a concomitant decrease in current loads below the capacity at higher flows as large volumes of water dilute the system. Until more data is presented at higher flow regimes, load allocations will be based on results at the lower flows (<80 cfs).

Fox and Spring Creeks

All temperature exceedances have been recorded in lower Fox and Springs Creeks. No exceedances were measure in upper Fox Creek during one year of sampling, and upper Spring Creek has not been sampled. These lower stream locations are generally after the creeks have experienced a degree of use for irrigation. Fox Creek returns to perennial flow in its lower portion largely as a result of springs, thus, its temperature is affected by the temperature of those springs and any impacts to shade producing vegetation in that lower area. Spring Creek on the other hand presumably flows perennially from its headwaters in most years. Temperature in Spring Creek may be influenced by upper spring temperatures and impacts to shade producing vegetation for its entire length. A good survey of spring outlet temperatures and riparian condition may be needed to ascertain areas needing restoration.

In order to include a margin of safety, the highest recorded temperature in each season was used as the current load. Thus, in Fox Creek 19.8^{o} C is the highest recorded temperature during the spring spawning period, and 14.2^{o} C was the highest daily average during that time period (Table 4). These recordings are 5^{o} to 7^{o} C warmer than associated criteria.

In Spring Creek, highest spring temperatures are 8^{o} to 9^{o} C greater than spring salmonid spawning criteria (Table 4). Spring Creek's highest summer temperature also exceeds cold water aquatic life criteria by 4^{o} C.

2.4 Load Allocation

Wasteload Allocation: There are no point source discharges in Moody, Fox or Spring Creeks. Therefore, there are no wasteload allocations (WLA = 0) in the TMDL equations.

Load Allocation:

Moody Creek

All allocations are dedicated to nonpoint sources as a whole and apply year-round. No attempt was made to divide the allocation amongst different nonpoint source activities or sources or different times of the year. The allocation is based on the highest current loading and the loading capacity at the current loading's measured discharge (Table 3). The highest TP current load was 87 lbs/day at 73 cfs. The loading capacity at 73 cfs would be 39.4 lbs/day; reduced by a 10% margin of safety (MOS) the target load becomes 35.5 lbs/day. The difference between the current load and the target load becomes the load allocation; -51.5 lbs/day TP or a 59% reduction).

Table 3. Nutrient Load Allocations for Moody Creek.

Parameter	Highest Current Load (lbs/day)	Flow (cfs)	Loading Capacity* (lbs/day)	Load Allocation (lbs/day)
TP	87	73	39.4	-51.5 (59% reduction)
N	316	73	118	-209.8 (66% reduction)

* LC = target concentration times flow plus 10% MOS.

For nitrogen, the highest current load of NO2 + NO3 is 316 lbs/day at 73 cfs. The loading capacity for nitrogen at 73 cfs is 118 lbs/day, reduced to a target load of 106.2 lbs/day by a 10% MOS. The load allocation is -209.8 lbs/day N or a reduction of 66%.

Based on Figures 5 and 6, load reductions are less at flows less than 73 cfs, and it is unknown what load reductions are necessary at higher flows. However, if current loading maintains the same trend at higher flows, then the percent reduction will remain the same. Thus, at 300 cfs the current trend for TP would increase to about 350 lbs/day and the loading capacity is 150 lbs/day. The reduction under this scenario is around 61% with a 10% MOS, similar to the calculated 59% reduction at 73 cfs.

<u>Fox and Spring Creeks</u>

Because cutthroat trout spawning is perhaps the species of most concern, and the most critical time period, spring spawning will be the focus of the needed reductions in temperature. Table 4 shows that Fox Creek has a load allocation of -6.8^{o}C with a necessary load reduction of 37% based on daily maximum temperatures. Spring Creek has a load allocation of -9.1^{o}C and a load reduction of 44%. Thes reductions include a 3% MOS. All applicable elements of the temperature criteria are also expected to be reached by achieving these reductions in daily maximum temperature.

Table 4. Load Allocations for Temperature in Fox and Spring Creeks.

Fox Creek	Temperature Statistic	Highest Recorded Temperature (Current Load)	Criteria (Loading Capacity)	Load Allocation	% Reduction *
Spring	Maximum Daily	19.8°C	13°C	-6.8°	37%
Spawning	Daily Average	14.2°C	9°C	-5.2°	40%
Fall	Maximum Daily	15.7°C	13°C	-2.7°	20%
Spawning	Daily Average	12.3°C	9°C	-3.3°	30%
Spring Creek					
Spring	Maximum Daily	22.1°C	13°C	-9.1°	44%
Spawning	Daily Average	17.5°C	9°C	-8.5°	52%
Summer	Maximum Daily	26.0°C	22°C	-4.0°	18%
	Daily Average	19.2°C	19°C	-0.2°	4%
Fall	Maximum Daily	20.5°C	13°C	-7.5°	40%
Spawning	Daily Average	13.5°C	9°C	-4.5°	36%

* % reduction includes a three percent MOS.

No allocation has been set aside for future increases in pollutant loadings as a result of growth or development in these TMDLs.

Margin of Safety

As described above, a 10% margin of safety was used to reduce the available loading capacity in the Moody Creek nutrient TMDL. The temperature TMDLs for Fox and Spring Creeks contain a 3% margin of safety instead of 10% because the highest recorded temperature was used as existing load rather than an average high temperature for all the sampling years.

Seasonal Variation

Critical conditions have been accounted for in all streams by considering seasonal conditions and the combination of environmental factors (flow and temperature) that would cause violation of criteria. Moody Creek has substantial seasonal variation in flow. This variation was taken into account by visualizing the loading on a flow rate basis. All available sampling data represent low flow conditions, and no information is available on the behavior of nutrient loading at peak flows. If loading trends remain the same at higher flows, then the percent reduction remains the same, but actual loads will be substantial at peak flows. Thus, the critical time period to control the most loading will be during the peak runoff.

Seasonal variation in temperature TMDLs is accounted for by using criteria that apply to specific time periods such as the spring spawning period and the summer aquatic life period.

Background

- The load allocation includes that which would be produced naturally. In the case of nutrients, some of the N and P load capacity belongs to natural background sources, however, their quantity is unknown.
- For temperature, quite often temperature criteria can be exceeded by natural background conditions in some years. No attempt has been made to isolate natural temperature regimes from the data on Fox and Spring Creeks.

2.5 Implementation Strategies

Most data used for the development of these TMDLs comes from the lower half of these streams, the majority of which is private ground. There are some data gaps regarding upstream pollutant loadings that should not be overlooked. Although temperature does not appear to be a problem in upper Fox Creek, that may not be true for Spring Creek. Regarding nutrient concentrations in Moody Creek, more information is needed to characterize the upstream contributions of phosphorus and nitrogen before specific implementation plans can be developed.

Since the overwhelming majority of land along Fox, Spring, and Moody Creeks is private agricultural ground, the Idaho Association of Conservation Districts (IASCD) will develop the largest portion of the implementation plan. Land use primarily consists of irrigated and non-irrigated cropland with small pockets of rangeland. Given this, implementation strategies will be based on Best Management Practices (BMPs) for treatment of agricultural nonpoint source water quality pollution.

DEQ recognizes that implementation strategies for TMDLs may need to be modified as site specific information becomes available.

Approach

In order to meet waste load allocations the IASCD will implement several BMPs to address nonpoint source agricultural water quality pollution. Specifications and BMPs utilized by the IASCD are those set forth by the Natural Resources Conservation Service (NRCS) (Smith 2003). In irrigated and non-irrigated cropland as well as rangeland, the development of riparian forest buffers will help increase canopy cover and thereby reduce stream temperatures. To address nutrient loading in cropland, the IASCD will implement field based residue management strategies which will include but not be limited to water and sediment basins and filter strips. Filter strips are like riparian buffers, but they are created with non-woody vegetation serving as a buffer between agricultural land and streams. Where necessary, prescribed grazing practices such as stubble height control and offsite watering will be implemented to reduce negative water quality impacts in rangeland areas. (Smith 2003)

Responsible Parties

IASCD staff will be responsible for installing specifications and improvements to achieve water quality standards. Staff from DEQ shall be responsible for coordinating implementation plans and strategies.

Monitoring Strategy

In order to measure implementation activities and the achievement of water quality standards, the IASCD will continue to monitor Moody Creek for total phosphorous and nitrate plus nitrite concentrations. Temperature loggers will be placed in Fox and Spring Creeks to identify any change in stream temperatures as a result of IASCD implementation activities.

2.6 Conclusions

Moody Creek, originating in the Big Hole Mountains and the sole tributary to the South Fork Teton River, was listed as water quality-limited by nutrients on the 1998 303d list. The *Teton River Subbasin Assessment and TMDL* (IDEQ, 2002) determined that the boundaries of the listed segment should change to include from the confluence of North and South Moody Creek to a location where the stream course becomes canal (tentatively identified as the confluence with Woodmansee Johnson Canal).

Water quality data collected by the Idaho Association of Soil Conservation Districts for 2001 and 2002 showed nitrogen and phosphorus levels greater than water quality targets as flow increased. Load allocations were determined based on the reduction needed to attain the target loading capacity at the highest measured flow. Total phosphorus and nitrate+nitrite nitrogen needs to reduce by 59% and 66%, respectively to reach target concentrations.

Fox and Spring Creeks are tributaries to the upper Teton River near Victor and Tetonia, respectively. These streams were identified in the *Teton River Subbasin Assessment and TMDL* (IDEQ, 2002) as being water quality limited for sediment and temperature. Sediment was addressed in that document and temperature was addressed here. Both streams were considered rainbow and cutthroat trout spawning waters, thus, recorded stream temperatures were compared to spring salmonid spawning criteria. Load allocations were calculated and necessary reductions are as high as 37% for Fox Creek and 44% for Spring Creek.

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GIS Coverages:

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Glossary

305(b)	Refers to section 305 subsection "b" of the Clean Water Act. 305(b) generally describes a report of each state's water quality, and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.
§303(d)	Refers to section 303 subsection "d" of the Clean Water Act. 303(d) requires states to develop a list of waterbodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.
Acre-Foot	A volume of water that would cover an acre to a depth of one foot. Often used to quantify reservoir storage and the annual discharge of large rivers.
Adsorption	The adhesion of one substance to the surface of another. Clays, for example, can adsorb phosphorus and organic molecules
Aeration	A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.
Aerobic	Describes life, processes, or conditions that require the presence of oxygen.
Assessment Database (ADB)	The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of waterbodies, and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.
Adfluvial	Describes fish whose life history involves seasonal migration from lakes to streams for spawning.
Adjunct	In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.

Alevin	A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a waterbody, living off stored yolk.
Algae	Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.
Alluvium	Unconsolidated recent stream deposition.
Ambient	General conditions in the environment. In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations, or specific disturbances such as a wastewater outfall (Armantrout 1998, EPA 1996).
Anadromous	Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the salt water but return to fresh water to spawn.
Anaerobic	Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.
Anoxia	The condition of oxygen absence or deficiency.
Anthropogenic	Relating to, or resulting from, the influence of human beings on nature.
Anti-Degradation	Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.56).
Aquatic	Occurring, growing, or living in water.
Aquifer	An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.
Assemblage (aquatic)	An association of interacting populations of organisms in a given waterbody; for example, a fish assemblage, or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).
Assimilative Capacity	The ability to process or dissipate pollutants without ill effect to beneficial uses.
Autotrophic	An organism is considered autotrophic if it uses carbon dioxide as its main source of carbon. This most commonly happens through photosynthesis.

Batholith	A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.
Bedload	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.
Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic biota, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.
Beneficial Use Reconnaissance Program (BURP)	A program for conducting systematic biological and physical habitat surveys of waterbodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers
Benthic	Pertaining to or living on or in the bottom sediments of a waterbody
Benthic Organic Matter.	The organic matter on the bottom of a waterbody.
Benthos	Organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the lake and stream bottoms.
Best Management Practices (BMPs)	Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.
Best Professional Judgment	A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information.
Biochemical Oxygen Demand (BOD)	The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time.
Biological Integrity	1) The condition of an aquatic community inhabiting unimpaired waterbodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).
Biomass	The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.
Biota	The animal and plant life of a given region.
Biotic	A term applied to the living components of an area.

Clean Water Act (CWA)	The Federal Water Pollution Control Act (commonly known as as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Coliform Bacteria	A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria).
Colluvium	Material transported to a site by gravity.
Community	A group of interacting organisms living together in a given place.
Conductivity	The ability of an aqueous solution to carry electric current, expressed in micro (µ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.
Cretaceous	The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. EPA develops criteria guidance; states establish criteria.
Cubic Feet per Second	A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.
Cultural Eutrophication	The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication).
Culturally Induced Erosion	Erosion caused by increased runoff or wind action due to the work of humans in deforestation, cultivation of the land, overgrazing, and disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion).
Debris Torrent	The sudden down slope movement of soil, rock, and vegetation on steep slopes, often caused by saturation from heavy rains.

Decomposition	The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.
Depth Fines	Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 mm depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 cm).
Designated Uses	Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.
Discharge	The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).
Dissolved Oxygen (DO)	The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.
Disturbance	Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.
E. coli	Short for *Escherichia Coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans. Their presence is often indicative of fecal contamination.
Ecology	The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.
Ecological Indicator	A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.
Ecological Integrity	The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).
Ecosystem	The interacting system of a biological community and its non-living (abiotic) environmental surroundings.
Effluent	A discharge of untreated, partially treated, or treated wastewater into a receiving waterbody.
Endangered Species	Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.

Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.
Eocene	An epoch of the early Tertiary period, after the Paleocene and before the Oligocene.
Eolian	Windblown, referring to the process of erosion, transport, and deposition of material by the wind.
Ephemeral Stream	A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table. (American Geologic Institute 1962).
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
Eutrophic	From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.
Eutrophication	1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.
Exceedance	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.
Existing Beneficial Use or Existing Use	A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).
Exotic Species	A species that is not native (indigenous) to a region.
Extrapolation	Estimation of unknown values by extending or projecting from known values.
Fauna	Animal life, especially the animals characteristic of a region, period, or special environment.
Fecal Coliform Bacteria	Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria).
Fecal Streptococci	A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.
Feedback Loop	In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress.
Fixed-Location Monitoring	Sampling or measuring environmental conditions continuously or repeatedly at the same location.

Flow	See Discharge.
Fluvial	In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.
Focal	Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.
Fully Supporting	In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).
Fully Supporting Cold Water	Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions (EPA 1997).
Fully Supporting but Threatened	An intermediate assessment category describing waterbodies that fully support beneficial uses, but have a declining trend in water quality conditions, which if not addressed, will lead to a "not fully supporting" status.
Geographical Information Systems (GIS)	A georeferenced database.
Geometric Mean	A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.
Grab Sample	A single sample collected at a particular time and place. It may represent the composition of the water in that water column.
Gradient	The slope of the land, water, or streambed surface.
Ground Water	Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.
Growth Rate	A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.
Habitat	The living place of an organism or community.
Headwater	The origin or beginning of a stream.
Hydrologic Basin	The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

Hydrologic Cycle	The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle.
Hydrologic Unit	One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.
Hydrologic Unit Code (HUC)	The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.
Hydrology	The science dealing with the properties, distribution, and circulation of water.
Impervious	Describes a surface, such as pavement, that water cannot penetrate.
Influent	A tributary stream.
Inorganic	Materials not derived from biological sources.
Instantaneous	A condition or measurement at a moment (instant) in time.
Intergravel Dissolved Oxygen	The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.
Intermittent Stream	1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.
Interstate Waters	Waters that flow across or form part of state or international boundaries, including boundaries with Indian nations.
Irrigation Return Flow	Surface (and subsurface) water that leaves a field following the application of irrigation water and eventually flows into streams.

Key Watershed	A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.
Knickpoint	Any interruption or break of slope.
Land Application	A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge.
Limiting Factor	A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.
Limnology	The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.
Load Allocation (LA)	A portion of a waterbody's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).
Load(ing)	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.
Loading Capacity (LC)	A determination of how much pollutant a waterbody can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.
Loam	Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.
Loess	A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible.
Lotic	An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth.
Luxury Consumption	A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a waterbody, such that aquatic plants take up and store an abundance in excess of the plants' current needs.
Macroinvertebrate	An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.

Macrophytes	Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.
Margin of Safety (MOS)	An implicit or explicit portion of a waterbody's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving waterbody. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.
Mass Wasting	A general term for the down slope movement of soil and rock material under the direct influence of gravity.
Mean	Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.
Median	The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; and 6 is the median of 1, 2, 5, 7, 9, 11.
Metric	1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.
Milligrams per liter (mg/L)	A unit of measure for concentration in water, essentially equivalent to parts per million (ppm).
Million gallons per day (MGD)	A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second.
Miocene	Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.
Monitoring	A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a waterbody.
Mouth	The location where flowing water enters into a larger waterbody.
National Pollution Discharge Elimination System (NPDES)	A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.
Natural Condition	A condition indistinguishable from that without human-caused disruptions.

Nitrogen	An element essential to plant growth, and thus is considered a nutrient.
Nodal	Areas that are separated from focal and adjunct habitats, but serve critical life history functions for individual native fish.
Nonpoint Source	A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Not Assessed (NA)	A concept and an assessment category describing waterbodies that have been studied, but are missing critical information needed to complete an assessment.
Not Attainable	A concept and an assessment category describing waterbodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning).
Not Fully Supporting	Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).
Not Fully Supporting Cold Water	At least one biological assemblage has been significantly modified beyond the natural range of its reference condition (EPA 1997).
Nuisance	Anything which is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.
Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.
Nutrient Cycling	The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).
Oligotrophic	The Greek term for "poorly nourished." This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity.
Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.

Orthophosphate	A form of soluble inorganic phosphorus most readily used for algal growth.
Oxygen-Demanding Materials	Those materials, mainly organic matter, in a waterbody that consume oxygen during decomposition.
Parameter	A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.
Partitioning	The sharing of limited resources by different races or species; use of different parts of the habitat, or the same habitat at different times. Also the separation of a chemical into two or more phases, such as partitioning of phosphorus between the water column and sediment.
Pathogens	Disease-producing organisms (e.g., bacteria, viruses, parasites).
Perennial Stream	A stream that flows year-around in most years.
Periphyton	Attached microflora (algae and diatoms) growing on the bottom of a waterbody or on submerged substrates, including larger plants.
Pesticide	Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.
pH	The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.
Phased TMDL	A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a waterbody. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.
Phosphorus	An element essential to plant growth, often in limited supply, and thus considered a nutrient.
Physiochemical	In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeable with the terms "physical/chemical" and "physicochemical."

Plankton	Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans.
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Pretreatment	The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant.
Primary Productivity	The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type, or direction.
Quality Assurance (QA)	A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training. The goal of QA is to assure the data provided are of the quality needed and claimed (Rand 1995, EPA 1996).
Quality Control (QC)	Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples. QC is implemented at the field or bench level (Rand 1995, EPA 1996).
Quantitative	Descriptive of size, magnitude, or degree.
Reach	A stream section with fairly homogenous physical characteristics.

Reconnaissance	An exploratory or preliminary survey of an area.
Reference	A physical or chemical quantity whose value is known, and thus is used to calibrate or standardize instruments.
Reference Condition	1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).
Reference Site	A specific locality on a waterbody that is minimally impaired and is representative of reference conditions for similar waterbodies.
Representative Sample	A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.
Resident	A term that describes fish that do not migrate.
Respiration	A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.
Riffle	A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.
Riparian	Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a waterbody.
Riparian Habitat Conservation Area (RHCA)	A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams: - 300 feet from perennial fish-bearing streams - 150 feet from perennial non-fish-bearing streams - 100 feet from intermittent streams, wetlands, and ponds in priority watersheds.
River	A large, natural, or human-modified stream that flows in a defined course or channel, or a series of diverging and converging channels.
Runoff	The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.
Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

Settleable Solids	The volume of material that settles out of one liter of water in one hour.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stagnation	The absence of mixing in a waterbody.
Stenothermal	Unable to tolerate a wide temperature range.
Stratification	A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).
Stream	A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.
Storm Water Runoff	Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.
Stressors	Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.
Subbasin	A large watershed of several hundred thousand acres. This is the name commonly given to 4th field hydrologic units (also see Hydrologic Unit).
Subbasin Assessment (SBA)	A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.
Subwatershed	A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th field hydrologic units.
Surface Fines	Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 mm depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff	Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.
Surface Water	All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.
Suspended Sediments	Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.
Taxon	Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).
Tertiary	An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs.
Thalweg	The center of a stream's current, where most of the water flows.
Threatened Species	Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
Total Maximum Daily Load (TMDL)	A TMDL is a waterbody's loading capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. TMDL = Loading Capacity = Load Allocation + Wasteload Allocation + Margin of Safety. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several waterbodies and/or pollutants within a given watershed.
Total Dissolved Solids	Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS) The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Greenborg, Clescevi, and Eaton 1995) call for using a filter of 2.0 micron or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Tributary A stream feeding into a larger stream or lake.

Trophic State The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

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Tributary A stream feeding into a larger stream or lake.

Trophic State The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

Turbidity A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Vadose Zone The unsaturated region from the soil surface to the ground water table.

Wasteload Allocation (WLA) The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a waterbody.

Waterbody	A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.
Water Column	Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.
Water Pollution	Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.
Water Quality	A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.
Water Quality Criteria	Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.
Water Quality Limited	A label that describes waterbodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.
Water Quality Limited Segment (WQLS)	Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."
Water Quality Management Plan	A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.
Water Quality Modeling	The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input variables such as climate, stream flow, and inflow water quality.
Water Quality Standards	State-adopted and EPA-approved ambient standards for waterbodies. The standards prescribe the use of the waterbody and establish the water quality criteria that must be met to protect designated uses.
Water Table	The upper surface of ground water; below this point, the soil is saturated with water.

Watershed	1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a waterbody.
Waterbody Identification Number (WBID)	A number that uniquely identifies a waterbody in Idaho ties in to the Idaho Water Quality Standards and GIS information.
Wetland	An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.
Young of the Year	Young fish born the year captured, evidence of spawning activity.

Appendix A. Unit Conversion Chart

Table A1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft^2) Square Miles (mi^2)	Hectares (ha) Square Meters (m^2) Square Kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (g) Cubic Feet (ft^3)	Liters (L) Cubic Meters (m^3)	1 g = 3.78 l 1 l = 0.26 g 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 g = 11.35 l 3 l = 0.79 g 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic Feet per Second (ft^3/sec)[1]	Cubic Meters per Second (m^3/sec)	1 ft^3/sec = 0.03 m^3/sec 1 m^3/sec = ft^3/sec	3 ft^3/sec = 0.09 m^3/sec 3 m^3/sec = 105.94 ft^3/sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L[2]	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 kg
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 ° C = 37.4 °F

[1] 1 ft^3/sec = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 ft^3/sec.

[2] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

Appendix B. State and Site-Specific Standards and Criteria

Nutrients Narrative Standard

IDAPA 58.01.02.200.

06. Excess Nutrients. Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses.

Temperature Standards

IDAPA 58.01.02. 250.

02. Cold Water. Waters designated for cold water aquatic life are to exhibit the following characteristics:

b. Water temperatures of twenty-two (22) degrees C or less with a maximum daily average of no greater than nineteen (19) degrees C.

e. Salmonid spawning: waters designated for salmonid spawning are to exhibit the following characteristics during the spawning period and incubation for the particular species inhabiting those waters:

ii. Water temperatures of thirteen (13) degrees C or less with a maximum daily average no greater than nine (9) degrees C.

Salmonid Spawning periods

From Grafe et al. 2002.

Fish Species	(Annually) Time Period	Fish Species	(Annually) Time Period
Chinook Salmon (spring/summer)	Aug 15 – June 1	Bull Trout	Sept 1 – Apr 1
Chinook salmon (fall)	Oct 1 – Apr 15	Kokanee salmon	Sept 1 – May 1
Sockeye salmon	Oct 1 – June 1	Mountain whitefish	Oct 15 – Mar 15
Steelhead trout	Apr 1 – July 15	Brown trout	Oct 1 – Apr 1
Redband/rainbow trout	Mar 15 – July 15	Brook trout	Oct 1 – June 1
Cutthroat trout	Apr 1 – July 1		

Appendix C. Data Sources

Table C1. Data sources for the Moody, Fox, and Spring Creeks TMDLs.

Waterbody	Data Source	Type of Data	When Collected
Moody Creek	Christine Fischer, IASCD	Water chemistry, flow	2001, 2002
Fox Creek	Bill Schrader, IDFG	Temperature	1996, 97, 98
Fox Creek	IDEQ	Temperature	2000, 2002
Spring Creek	IDEQ	Temperature	2000, 2002

Appendix D. Distribution List

Sheryl Hill, Lyn Benjamin (Friends of the Teton River),
Dale Swensen (Fremont Madison Irr Dist),
Darwin Joshephsen (Chairman WQ Sub),
Steve Smart (High Country RC&D),
Steve Ray (NRCS),
Steve Smith (IASCD),
Mike Whitfield (Teton Regional Land Trust),
Alicia Lane (BOR),
Dick Bauman (BOR),
Cleve Bagley (NRCS),
Lloyd Bradshaw (NRCS),
Chris Fischer (IASCD),
Gary Vecellio (IDFG),
Gerry Shelke (INEEL),
Heath Hancock (IDL),
Kim Ball (Friends of the Teton River),
Lee Mabey (USFS),
Mike Beus (BOR),
MIke Philbin (USFS),
Rob VanKirk (ISU),
Susan Steinman (Henrys Fork Foundation),
Madison SWCD and Teton SWCD.

Appendix E. Public Comments

Public Participation

The Teton subbasin assessment and Moody, Fox, and Spring Creeks TMDLs were developed with the cooperation and participation of the Henry's Fork Watershed Council as the designated Watershed Advisory Group and local, state, and federal agencies and interested citizens throughout the basin and region.

The draft version of the *Supplement to the Teton River Total Maximum Daily Load – Moody, Fox, and Spring Creeks* was available for public comment from April 21, 2003, through May 23, 2002. The draft was mailed to members of the Henry's Fork Watershed Council Water Quality Subcommittee and other interested parties. Copies were made available for review at the DEQ Idaho Falls Regional Office; Public Libraries in Idaho Falls, Victor, and Rexburg; and in PDF format on DEQ's website at www.deq.state.id.us/water/tmdls/tmdls.htm.

A Public meeting to discuss the content of the *Supplement to the Teton River Total Maximum Daily Load – Moody, Fox, and Spring Creeks* occurred on April 29, 2003 at the Driggs USDA Service Center. A presentation regarding the TMDL was made on March 10, 2001 to the Henry's Fork Watershed Council Waster Quality Subcommittee meeting in Driggs. Public notices advertising the availability of the draft, major conclusions, and request for comments were published in the *Idaho Falls Post Register*, *Teton Valley News*, and the *Rexburg Standard Journal* newspapers during the duration of the comment period.

Comments were received from EPA, Region 10 and a citizen, Kate West of Victor, Idaho. Comments received from the EPA and Kate West are included with responses. Responses to comments are in bold print following the individual comment when possible.

Comments from EPA Region 10, Seattle, WA

May 29, 2003

EPA Region 10 would like to acknowledge the considerable technical work and effort that the DEQ staff have put forth in developing these TMDLs. We have prepared the following comments based on our review of the document together with the *Teton Subbasin Assessment and TMDLs*, dated July 30, 2002.

Executive Summary

In the second paragraph, it would be helpful to indicate that the July 2002 Teton River Subbasin Assessment (SBA) document (IDEQ, 2002) also contains the analytical data for the subbasin. For clarity, it should also be stated that the data and information presented in the SBA was relied upon for the development of these TMDLs.

Revisions were made to address this comment.

Under Key Findings or in Section 1.1 of the Introduction, it is suggested that the beneficial uses for each of the streams be specifically stated, or presented in a table.

Revisions were made to address this comment.

Introduction

Page 4, Idaho's Role, second paragraph. Please indicate the IDAPA section numbers which define each of the beneficial uses, or reference where in the SBA the information is presented (i.e. page 44). It would also help to reference Appendix B where the relevant water quality criteria are presented. Specifically referencing the State codes helps clarify the official record for the TMDL approval.

Revisions were made to address this comment.

The proposed boundary change for Moody Creek presented on page 5 is a 303(d) listing action and is subject to final agency determination under a separate administrative process. Comments will be provided separately during that process. It should be considered whether the nuisance criteria is being violated within the stream segment proposed for removal when evaluating the boundary change. Regardless of which boundary is included in the revised 303(d) list, it should not affect the TMDL as presented.

Revisions were made to address this comment.

Total Maximum Daily Loads

Target Selection, first bullet. Please reference how the nutrient targets were derived (EPA Gold Book, etc.). If a discussion is provided in the SBA, referencing the section of the SBA where it is presented may also be helpful.

Revisions were made to address this comment.

Moody Creek, page 8, first paragraph. Please indicate where the nutrient data is presented (i.e. Appendix I of the SBA). Also, if the TMDL analysis included additional data collected subsequent to the SBA, it should be mentioned for the record. If there is additional data, it should be mentioned that it is referenced in Table C-1 of the Addendix, Data Sources.

Revisions were made to address this comment.

Page 10 and 11, Fox Creek and Spring Creek, first paragraphs. Per above, please indicate where the temperature data is presented or available in the state records.

Revisions were made to address this comment.

2.2 Load Capacity, last two sentences. For clarity, it is suggested that the loading capacity target be included in these sentences; i.e. Total phosphorous loading capacity at 0.1 mg/l varies from 5 lbs/day...and nitrogen loading capacity at 0.3 mg/l varies from...

Revisions were made to address this comment.

2.3 Estimates of Existing Loads, Fox and Spring creeks. Since the temperature TMDLs use the criteria as the Loading Capacity and assigns % reductions in temperature needed to achieve them, a short discussion of the location and nature of potential sources of heating would be helpful . This 'Source Assessment' would help guide implementation by identifying priority areas for restoration as well as identifying what measures, such as revegetation, stream bank stabilization, or other BMPs, could be used to achieve the criteria.

Revisions were made to address this comment.

2.4 Load Allocations, first paragraph. A statement should be included here or elsewhere in this section that no future growth has been accounted for in the TMDLs.

Revisions were made to address this comment.

Load Allocations, Moody Creek, first or second paragraph. A statement should be included here as to whether the Load Allocations and TMDL will apply year-round or seasonally. If it is seasonal, the dates should be specified. Although the reductions may only be needed in summer, for simplicity DEQ has at times applied nutrient TMDLs year-round based on the assumption that BMPs would be implemented all year. Either approach would be acceptable.

Revisions were made to address this comment.

Table 3. For clarity, please provide some explanation of the formula that was used to get from Flow to the Loading Capacity (it is assumed to be daily load/ flow plus 10% for MOS).

Revisions were made to address this comment.

Page 16, Fox and Spring Creeks. Please indicate whether the reduction in the Spring Maximum Daily temperatures (34% and 41%) will also result in compliance with Daily Average temperatures for the streams for each season. A statement that all applicable elements of the temperature criteria are also expected to be reached would make this clear.

Revisions were made to address this comment.

Margin of Safety. For the temperature TMDLs, the implicit MOS provided may not be a conservative assumption. The MOS must apply under all conditions. For instance, at the highest recorded temperature, which was used to set the reductions needed, the full 34% and 41% reduction would be required to meet the criteria. Under those circumstances there would not be a MOS. If, however, the high temperature was recorded during an exempt period per IDAPA 58.01.02.080.04 (Temperature Exemption), then it could be considered a

MOS. Alternatively, adding an additional X % reduction to the 34% and 41% proposed (i.e. 3% for 37% and 44%) is another option for a MOS.

Revisions were made to address this comment.

Seasonal Variation. A statement should be included regarding how 'critical conditions have been accounted for in all streams by considering seasonal conditions and the combination of environmental factors (flow and temperature) that would cause violation of the criteria.'

Revisions were made to address this comment.

The addition of a short discussion concerning Data Gaps would give some guidance for future data collection and monitoring as well as identifying where additional data could guide future revisions to the TMDLs.

Revisions were made to address this comment.

Either in the document or the cover letter, please include a section on Public Participation for the record. This should include the measures used to incorporate public participation in the process of developing the TMDLs.

Revisions were made to address this comment.

Comments from Kate West

May 19, 2003

I appreciate the Teton River Subbasin Assessment and Total Maximum Daily Load document. I read much of it so that I could make an informed comment, however I didn't have time to finish reading it. I think that it is a good document that covers many of the issues of concern – erosion of riverbanks, sediments, excess nutrients in the river water and its tributaries. I especially am grateful that there are incentives to encourage farmers to mitigate these problems. I am aware that there are also problems caused by people building new houses. I am hoping that these issues are taken into consideration by the Teton County Planning and Zoning Commission.

I am sorry that this isn't a better comment letter. The document was interesting, and although I found myself having some trouble with the statistics, I think I got the gist of what I read. I just ran out of time. Thanks for all that you do to help protect our resources.

Sincerely,
Kay West

DEQ will continue to work with interested parties focus on issues addressed in the Teton Subbasin Assessment and the Fox, Moody, and Spring Creeks TMDL. The DEQ will remain committed to drafting documents that are understandable and not overly verbose.